Software Engineering in Practice
Software testing

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Assignment (Software Testing)

- Perform the following tasks on a popular open source project:
  - identify software testing levels,
  - study what testing techniques are used,
  - present metrics that evaluate the testing coverage for this open source project with respect to basic characteristics of the project (e.g., lines of code, reported issues, number of test cases, etc.), and
  - propose additional testing techniques and tool categories that can be used on this project.

Definition

Dynamic verification that a program provides *expected* behaviours on a suitably selected *finite* set of test cases.

Terminology

- Verification: are we building the product right?
- Validation: are we building the right product?
- Fault leads to …
- … failure

Test levels

- Unit testing
- Integration testing
- System testing

Objectives of testing

- Beta testing

- Acceptance testing
- Installation testing
- A/B testing
- Regression testing
- Performance testing
- Stress testing
- Recovery testing
- Interface testing
- Configuration testing
- Usability testing

Example: A/B testing

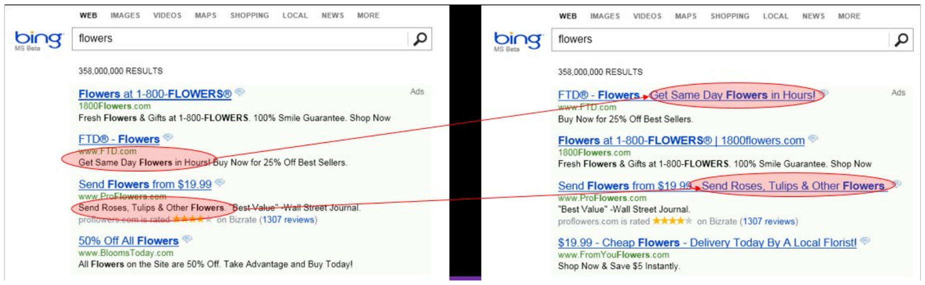

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Figure 1: A/B testing example

(From Ronny Kohavi's presentation)

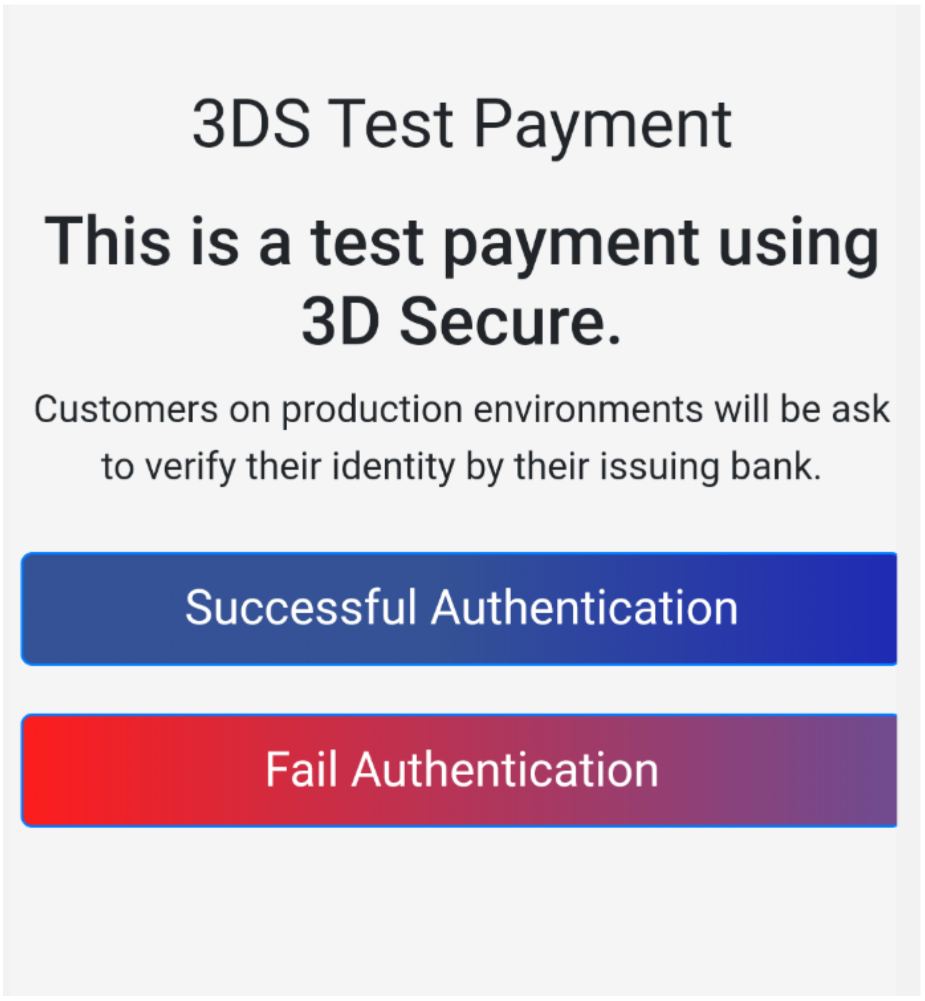
Example: Test sandbox

Test techniques

- Ad hoc
- Exploratory testing
- Boundary-values analysis
- Random, fuzz testing
- Control flow-based criteria
- Data flow-based criteria (definitions, uses, combinations)
- Error guessing

Test-related measures

- Fault history
- Fault classification
- Fault density
- Reliability growth models



3DS Test Payment

This is a test payment using 3D Secure.

Customers on production environments will be ask to verify their identity by their issuing bank.

Figure 2: Credit card payment sandbox

- Reliability evaluation

Evaluation of the tests performed

- Based on coverage/thoroughness measures
- Based on the detection of artificially introduced faults (fault injection)

Practical considerations

- Failing tests signify appropriate testing
- Test process management and guides
- Test documentation
- Test-driven development (TDD)
- Internal vs independent test teams
- Risk assessment-based termination of testing

Test activities

- Planning
- Test-case development
- Testing environment
- Continuous integration
- Test execution
- Test results evaluation
- Problem reporting/test log
- Defect tracking

Example: Test plan

- Identification
- Introduction
- Elements for testing (test scope)
  - Features to be tested
  - Features not to be tested
- Methodology
- Acceptance criteria
- Suspension criteria & resumption requirements
- Deliverables
- Test tasks
- Test environment
- Responsibilities (per team)
- Staffing and training needs
- Time schedule
- Issue handling
- Approval

Documentation example

- Test plan specifications
- Test case specifications
  - Unique identifier
  - Parts that will be tested
  - Inputs' definition
  - Expected results
  - Environment requirements
  - Process requirements
  - Dependencies
- Test process specifications
- Test elements submission report
- Test log
- Testing report

Software testing tools, techniques

- Test harness
- Test generators
- Capture and replay tools
- Oracle/file comparators/assertion checking tools
- Test execution systems
- Unit test tools
- Mocking
- Tracers
- Coverage analysers
- Fault injectors
- Regression testing tools

Example: test coverage with gcov

```
     1    if (*++argv && !strcmp(*argv, "-n")) {
######            ++argv;
######            nflag = 1;
          }
          else
     1            nflag = 0;
     3    while (*argv) {
     2            (void)printf("%s", *argv);
     2            if (*++argv)
     1                    putchar(' ');
          }
     1    if (!nflag)
     1            putchar('\n');
     1    exit(0);
```

Example: Statement coverage (Perl)

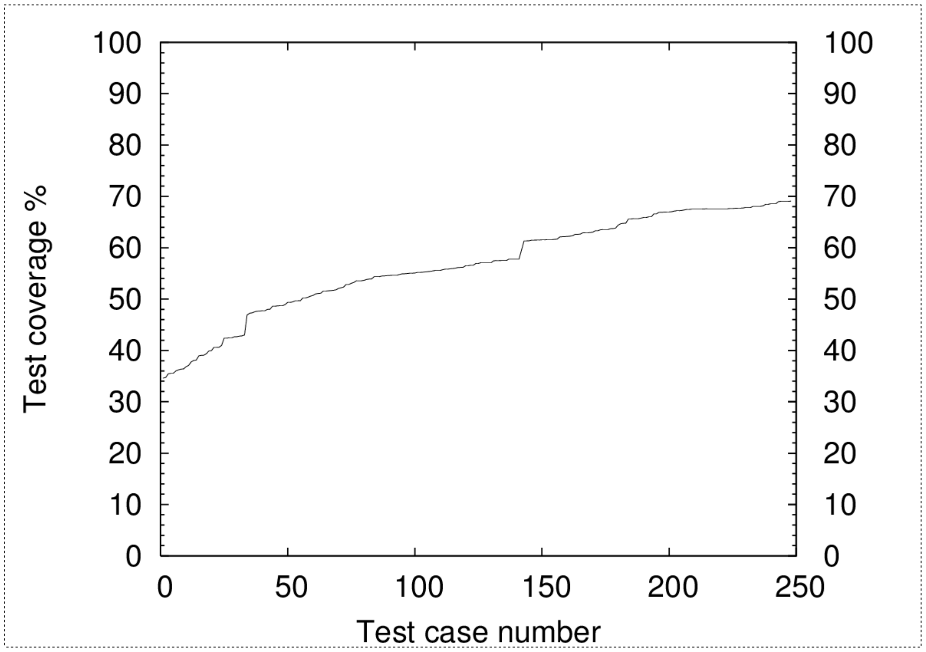


Figure 3: Perl statement coverage

Example: Branch coverage (Perl)

Example: Unit test

```
public class MoneyTest extends TestCase {
    private Money f12CHF;
    private Money f14CHF;
    private Money f28USD;

    protected void setUp() {
        f12CHF= new Money(12, "CHF");
        f14CHF= new Money(14, "CHF");
        f28USD= new Money(28, "USD");
    }
}

public void testMoneyMoneyBag() {
    // [12 CHF] + [14 CHF] + [28 USD] == {[26 CHF][28 USD]}
    Money bag[]= { f26CHF, f28USD };
    MoneyBag expected= new MoneyBag(bag);
```

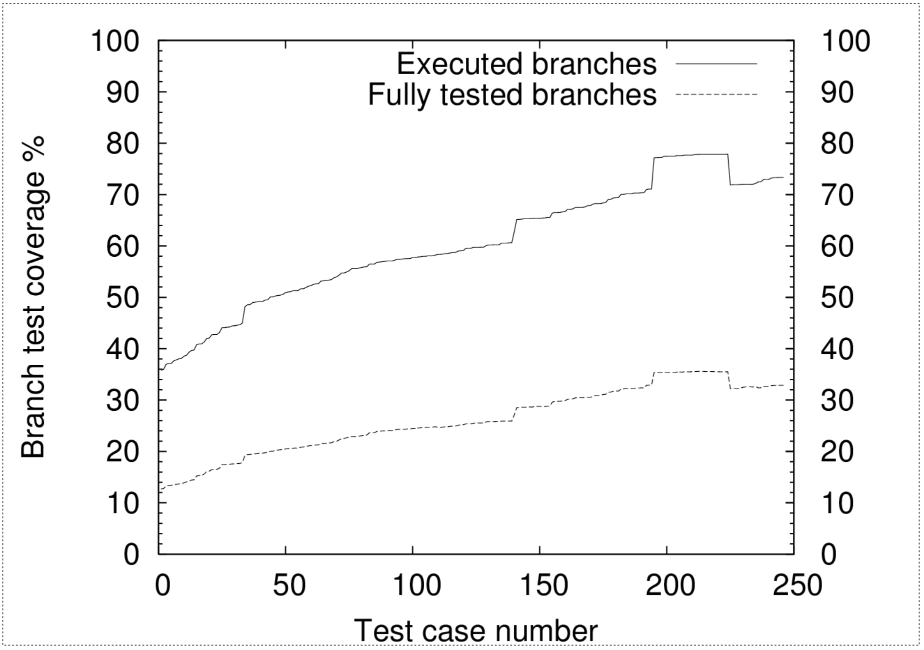


Figure 4: Perl branch coverage

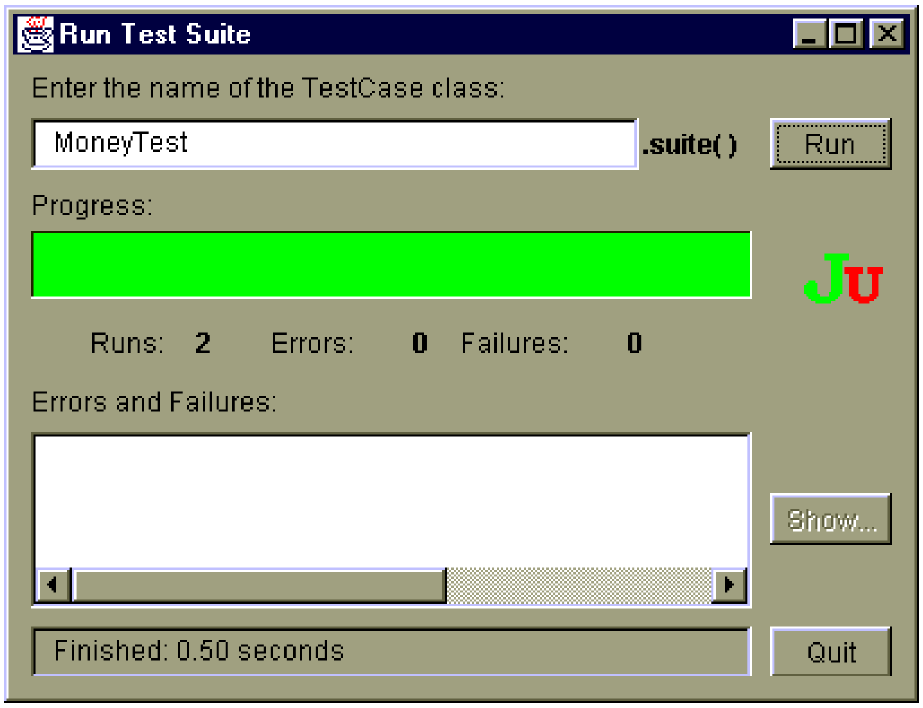
```
    assertEquals(expected, f12CHF.add(f28USD.add(f14CHF)));
}

public static Test suite() {
    TestSuite suite= new TestSuite();
    suite.addTest(new MoneyTest("testMoneyEquals"));
    suite.addTest(new MoneyTest("testSimpleAdd"));
    return suite;
}
```

Example: JUnit

Assignment (Software Maintenance)

- Select a popular open source project and study its maintenance:
  - identify maintenance activities and related techniques,
  - propose appropriate metrics for evaluating the current maintenance of the project,
  - identify requirements for further maintenance and relevant techniques, and
  - classify under the maintenance categories the activities and the techniques that you identified.



Run Test Suite

Enter the name of the TestCase class:

MoneyTest .suite( )

Progress:

Runs: 2 Errors: 0 Failures: 0

Errors and Failures:

Finished: 0.50 seconds

Figure 5: JUnit execution

Further Reading

- Kent Beck: Test Desiderata